Statement of Work

LSR Technologies and its subcontractors will design and build a 8,500 m3/hr (5,000 acfm) Advanced ElectroCore? system and test it using an exhaust gas slipstream at Alabama Power Company's Gaston Steam Plant. The exhaust gas will be from Unit #4 of a 270 MWe sub-critical, pulverized coal boiler burning a low-sulfur Power-River Basin (PRB) coal. The Advanced ElectroCore system will consist of a conventional upstream ESP, a dry SO2 scrubber, a particle precharger and an Advanced ElectroCore separator. Particle concentrations and size distributions will be measured at the ESP inlet, at the dry scrubber outlet and at the ElectroCore outlet. The concentration of 12 common HAPs will be measured at these locations as well. The system is shown schematically in Figure 1.3-1. For purposes of project organization and monitoring, the work will be divided into nine (9) tasks described below.

Task 1 - Advanced ElectroCore Electrode Evaluation

In the Advanced ElectroCore an energized central electrode is added along the vertical centerline. LSR will evaluate the new electrode design using a conventional ElectroCore? and modifying it to accept the central electrode. The purpose of this task is to perfect the design for both supporting and electrifying the electrode. This involves designing the high voltage cable feed-through and the appropriate sizing and placement of corona shields within the upper and lower support housings. The shape and diameter and of the discharge electrode need to be selected to achieve high field strength with a low current density. The design needs to be tested with over a period of weeks to determine if there are any problems with fouling or cleanability. The electrode evaluation tests will be conducted by Southern Research Institute (SRI) using electrodes and support systems designed by LSR.

Task 2 - Advanced ElectroCore System Component Design

The second task will be to design the components of the 8,500 m3/hr (5,000 acfm) Advanced ElectroCore? system. Since the ESP is already in place, the dry scrubber, precharger and the Advanced ElectroCore? will need to be designed.

Figure 1.3-1: Advanced ElectroCore? System Schematic With Nominal Flow Rates

Dry Scrubber

The dry scrubber will be a vertical chamber with the gas flowing vertically downward. The diameter will provide a residence time of about 1 second. The top of the scrubber will contain a feeder for dry solid sorbent feed as well as a water injection system to control gas temperature at the outlet. The chamber will be fitted with insulation and clean-out connections. Design drawings will be done by LSR technologies under guidance provided by Dr. Ken Olen of Global Energy Service.

Precharger

The precharger will be designed as a conventional dry precharger with weighted wire discharge electrodes. The precharger length and cross-sectional area and the current density will be selected so that the particles will achieve over 90 percent of their saturation charge. As with the dry scrubber, the precharger will be insulated to reduce heat loss that might cause condensation problems since the gas leaving the dry scrubber may be within 15øC to 30øC (25ø to 50øF) of the dew point.

An important consideration of the design is that the precharger be able to be transported and assembled quickly on site. The components will be interlocking and be provided with lifting points to facilitate assembly. The precharger will be powered by an SCR controller and monitored using a spark rate controller to provide long term unmanned operation. The precharger will be designed by Merrick Environmental from specifications for field strength, residence time and current density provided by LSR Technologies.

Advanced ElectroCore? Separator

The Advanced ElectroCore separator will be designed with a capacity of 8,500 m3/hr (5,000 acfm) at a Specific Separating Area of 20 m2/(m3/s) (100 ft2/kacfm). The unit will contain ten (10) 0.4 meter (16 inch) diameter separators that are about 25 feet in height. It will be fitted with flanges for connection to the precharger, to the clean flow outlet duct and the bleed flow recirculation duct. The unit will be thermally insulated to help prevent condensation as described in the precharger design. The unit will be designed with an upper and lower half that can be disconnected to facilitate transport on a flat bed truck. Together with the precharger, this unit will be designed for easy transport and setup for use as a mobile unit after the completion of this project.

The Advanced ElectroCore Separator will have a single SCR type power supply to provide high voltage to the electrode array within the separators. The power supply will be monitored using a spark rate controller to provide long term unmanned operation. The separator will also be fitted with corona shields, grounded ductwork and electrical interlocks to meet the requirements of all electrical codes. The conceptual design of the ElectroCore separator components will be performed by the principle investigator together with the design staff at LSR. The preliminary design will be completed by Merrick Environmental based on LSR's conceptual design drawings. LSR, Merrick Environmental, and Alabama Power will collaborate to ensure the system fits within the available space and that connections are available and sized properly.

Task 3 - System Construction

The Advanced ElectroCore construction drawings that are created in Task 1, will be released for bidding to local fabrication shops. LSR will oversee the fabrication of the dry scrubber and the connecting ductwork. The precharger will be manufactured by Merrick Environmental and shipped to the field site directly.

Task 4 - System Transport and Installation

The ElectroCore? components will be truck-mounted and shipped to Gaston Station on a flatbed truck. At Gaston station, the components will be off-lifted by crane and placed alongside the Unit #4 ESP. The installation process will be performed by Southern Energy Constructors, a local contractor with union labor and an approval contractor of Alabama Power Company. LSR will have representation on site to oversee the assembly process and to insure that the installation is performed properly.

Task 5 - System Shakedown

The shakedown tests will be conducted by LSR to ensure that the gas flow rates are within specification and that the power supplies for the precharger and ElectroCore are operating at proper output. Preliminary traverses called for in EPA Method 5 will be performed at the ESP inlet, the dry scrubber outlet, and at ElectroCore outlet. This will ensure that the Method 5 test planes are properly set up and the ducts can be traversed in both planes. The power supplies and control system will be thoroughly checked out. The shakedown will be performed by LSR engineers with assistance from Merrick Environmental and Alabama Power personnel.

Task 6 - Field Testing

Field testing will be divided into three subtasks. In the first subtask, efficiency of the ElectroCore system will be measured as a function of gas flow rate and ESP efficiency. The ESP efficiency will be reduced from its maximum by lowering the voltage to its two electrical sections. Gas flow will be changed by varying the speed of the ID fan with an inverter-type variable speed drive. No sorbents will be introduced into the dry scrubber during these baseline tests. Particle concentration will be measured simultaneously at the ESP inlet, dry scrubber outlet, and ElectroCore? outlet using three Method 5 sampling trains and high-volume cascade impactors. Due to the large difference in particle concentration between the ESP inlet and ElectroCore outlet (approximately 10,000:1), tests may require several hours to complete at the ElectroCore? outlet. To overcome this problem, a high-volume modified Method 5 Sampler developed in France may be used to reduce sample time.

At the ESP inlet, using EPA Method 1, the inlet sampling plane will be designed for 8 traverse locations. The test will use a cascade impactor with a pre-cutter for removal of the coarsest fraction. The impactor will be used to sample the 8 traverse points in the first few minutes of the test. The impactor will be removed from the duct and an EPA Method 5 probe will be inserted and sampling will continue. As the test ends, a fresh impactor will be inserted for a final impactor traverse. The average inlet size distribution will be calculated by plotting the mass fraction versus particle diameter on a log-normal graph. The inlet loading will be determined from the EPA Method 5 test data.

To assure accuracy of the measurements, an analytical balance accurate to 2 æg will be used to weigh the outlet impactor stages. With the inlet and outlet size distributions and particle loading data, the fractional efficiency curve for the complete system can be determined. The goal will be to show that the fractional efficiency curve is above 99.99 percent for all particulate as specified in the project objectives.

The test matrix for task 6-1 is shown below in Table 1.3-1. Table 1.3-1 represents only 15 test points but, given the fact that each test involves simultaneous testing at three separate sampling planes, this represents a significant amount of work.

Table 1.3-1: Baseline Performance Test Matrix

Parameter	Minimum	Maximum	Increment
ESP Efficiency	90 percent	98 percent	4 percent
Gas Flow Rate	6800 m3/hr (4000 acfm)	10200 m3/hr (6000 acfm)	850 m3/hr (500 acfm)

Armstrong Environmental will perform the EPA Method 5 and impactor measurements. LSR will observe and oversee the conditions for testing, but will not be directly involved in the measurements. By using the resources of an outside testing company, testing will be faster and the results will have credibility having been collected from an independent party.

The purpose of the second subtask is to demonstrate that the ElectroCore? system can operate with high collection efficiency when sorbents are injected into flue gas stream. The purpose of this test is not to measure sulfur capture and no sulfur measurements will be made. The test is designed solely to demonstrate the ElectroCore? efficiency when using dry sorbent injection. The procedures used in task 6-1 will be repeated here except that sorbents will be injected at the top of the dry scrubber. Hydrated lime, activated carbon and pressure hydrated lime-silica will be used as test sorbents. The hydrated lime and pressure hydrated lime-silica will be injected at a rate to produce a calcium to sulfur mole ratio of between 1 and 2. Water will also be injected into the gas stream to reduce the flue gas temperature to within 56 øC (100 øF) to 11 øC (20 øF) of the dew point. The goal will be to demonstrate 99.99 percent system capture efficiency for all primary particulate. Table 1.3-2 shows the test matrix for subtask 6-2.

Table 1.3-2: Performance With Sorbent Test Matrix

Parameter	Minimum	Maximum	Increment
Lime Injection Rate (mol.)	1.0 Ca/S	2.0 Ca/S	0.5 Ca/S
Carbon Injection Rate (wt.)	10,000 C/Hg Mole Fraction	30,000 C/Hg Mole Fraction	10,000 C/Hg Mole Fraction
Flue Gas Temperature (Approach to Saturation)	11 øC (20 øF)	56 øC (100 øF)	22.5 øC (40.5 øF)

The final subtask will be the measurement of the removal of hazardous air pollutants (HAPs). The HAPs measurements will be conducted simultaneously at the ESP inlet, at the dry scrubber outlet and at the ElectroCore? outlet. The concentration of HAPs will be measured at 4 operating conditions with each point being tested twice for repeatability. The gas flow rates will be the same as used in task 6-2. Two tests will be conducted without sorbent injection, two will be conducted with hydrated lime injection, two will be conducted with pressure hydrated lime-silica, and two will be conducted with activated carbon injection. The tests will be conducted under the supervision of Cooper Environmental Services. The test method involves inserting a bank of filters into the duct, as used in EPA Method 17. The first filter is a quartz filter to trap the solid phase material. After the gas passes through the quartz filter, it passes through a resin impregnated filter that traps vapor phase ionic species such as ionic mercury. The gas then passes through a carbon impregnated filter where all the vapor phase species including elemental mercury are trapped. At the conclusion of each test, the filters are to be packed in sealed containers and sent to Cooper Environmental Systems for analysis.

As with the tests in subtask 6-1, the issue of 10000:1 inlet to outlet concentration ratio will be of concern during these tests as well. The problem will be overcome by using intermittent sampling at the ESP inlet. By sampling, for example, for only 30 seconds during each half-hour period and turning the sampling nozzle downstream during non-sampling intervals, a reasonably representative sample of the inlet HAPs over the duration of the test can be achieved.

Task 7 - Data Analysis / Cost Analysis

The field test results will provide data to evaluate performance and determine the size of the ElectroCore? needed to achieve 99.99% capture efficiency for a given gas flow rate. This information will be used to update the cost analysis data prepared for the conventional ElectroCore? in 1996 by Sargent & Lundy, LLC. The update will involve adding the cost of electrodes and power supplies to the separator section and to adjust the flow capacity of the unit. The goal is to show that capital and O&M costs of an ElectroCore? system is competitive with the best currently available retrofit technology.

Task 8 - Dismantle Equipment/Site Restoration

The final work to be done at the Alabama Power Company field site is to remove the ElectroCore? equipment and restore the test site to its original condition. This involves dissembling the system components and removing them from the site. Ductwork will be removed, and all electrical, water and other services restored.

Task 9 - Management & Reporting

The project will be managed appropriately to insure that all tasks are completed on schedule (Figure 1.3-2) and within budget. All technical and cost reporting requirements of the contract will be completed in this task.